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EP99/8901

PA 161851

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FILING DATE UNDER 35 USC 111.**

**APPLICATION NUMBER: 60/107,420****FILING DATE: November 06, 1998****PRIORITY  
DOCUMENT**

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## PROVISIONAL APPLICATION COVER SHEET

EM415838555US

A/PROV

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(b)(2).

|  |                  |                |  |                                      |               |
|--|------------------|----------------|--|--------------------------------------|---------------|
| Docket Number  |                  | TS-0764 (US)   |  | Type a plus sign (+) inside this box | +             |
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|  |                  |                |  |                                      |               |
|  |                  |                |  |                                      |               |
| TITLE OF THE INVENTION (280 characters max)  |                  |                |  |                                      |               |
| SEPARATOR APPARATUS  |                  |                |  |                                      |               |
| CORRESPONDENCE ADDRESS   |                  |                |  |                                      |               |
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| STATE  | Texas            | ZIP CODE       | 77252-2463   | COUNTRY                              | United States |
| ENCLOSED APPLICATION PARTS (check all that apply)  |                  |                |  |                                      |               |
| <input checked="" type="checkbox"/> Specification  | Number of Pages  | 10             | <input type="checkbox"/> Small Entity Statement      |                                      |               |
| <input checked="" type="checkbox"/> Drawing(s)   | Number of Sheets | 4              | <input type="checkbox"/> Other (specify)             |                                      |               |
| METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)         |                  |                |  |                                      |               |
| <input type="checkbox"/> A check or money order is enclosed to cover the Provisional filing fees |                  |                |  | FILING FEE AMOUNT(S)                 | \$150         |
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| filing fees and credit Deposit Account Number: 19-1800   |                  |                |  |                                      |               |

Respectfully submitted,

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PROVISIONAL APPLICATION FILING ONLY

TS 0764 USA

Crw

## SEPARATOR APPARATUS

Background of the invention

The invention is directed to a separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

5        an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing;

         a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes  
10       substantially co-axial from the top of the housing;

         inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing.

         Such an apparatus is described in US-A-5391289. This patent publication describes a cyclone separator which is  
15       used as a secondary separation step to separate solid catalyst particles from the reactor effluent of a fluid catalytic cracking (FCC) reactor. In a FCC process hydrocarbons are cracked at high temperature in the presence of a solid catalyst to more desired components,  
20       for example gasoline and lower olefins. In the field of FCC these cyclone separators are also referred to as secondary cyclones. Other publications describing these secondary cyclones in a FCC process are for example US-A-5055177, US-A-5376339, EP-A-299650, EP-A-488549 and  
25       EP-A-309244.

         A disadvantage of these secondary cyclones is that coke deposit may form on the walls of these apparatuses. Coke forming is a result of the hydrocarbons present in the feed to the cyclone and the relatively high  
30       temperatures of the gasses fed to the cyclones. Large

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pieces of coke can fall from the wall into the dipleg and cause to clog the dipleg. When a dipleg is clogged the cyclone will not function in an optimal manner as a solid-gas separator and the fluid catalytic cracking process will have to be shut down in order to remove the coke from the dipleg. Because FCC processes are expected to run many months and even years between planned shutdowns any unexpected shutdown will cause considerable economic damage.

The object of this invention is to avoid the problems associated with clogging of the diplegs of the separator apparatus.

Summary of the invention

The object is achieved by the following apparatus. A separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing; a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes substantially co-axial from the top of the housing, inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing; and a sieve positioned between the lower part of the circular housing and the upper part of the dipleg, which sieve has openings which do not allow particles having a diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg and wherein the total area of the openings in the sieve is greater than 2 times the cross sectional area of the dipleg.

It has been found that when such a sieve is used less problems due to clogging of the dipleg occur. Because of the sieve a reduction of the normal swirl movement in the dipleg is observed. As a result the pressure difference

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per length of dipleg will increase making it possible to use a shorter dipleg. This is very advantageous, especially when these cyclones are present within a vessel, for example a stripping vessel of a FCC process. The length of a dipleg is often the determining factor for the dimensions of the vessel. Thus shorter diplegs result in that smaller vessels can be employed.

#### Brief description of the drawings

The invention shall be further elucidated by means of the following figures. Figure 1 represent a vertical cross section of the separator apparatus according the invention. Figure 2 represents another embodiment of the invention, wherein the lower part of the housing is not present. Figure 3 represents a possible embodiment for a sieve combined with a vortex stabiliser. Figure 4 represents the upper part of a stripping vessel of a FCC process.

#### Detailed description of the invention

Preferably the openings of the sieve do not allow particles greater than 0.5 times the diameter ( $D_0$ ) of the dipleg to pass the sieve.

Preferably the total area ( $A_0$ ) of the openings of the sieve is greater than 5 times the cross sectional area ( $A_1$ ) of the dipleg.

The circular housing of the separator may suitably have an upper tubular portion with a diameter ( $D_3$ ), a conical formed housing as a middle portion of which smaller diameter ( $D_2$ ) is at the lower end and optionally a lower part having a diameter ( $D_1$ ) which is greater than the diameter ( $D_2$ ) of the lower part of the conical housing. The diameter ( $D_0$ ) of the dipleg is suitably smaller than the diameter ( $D_3$ ) of the upper part of the circular housing of the separator. Preferably the volume of the circular housing at the level where the sieve is located is sufficiently large to allow coke particles to

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accumulate. The dimensions of the sieve will be so chosen that while coke particles accumulate in the lower part of the housing a sufficiently large number of openings are not blocked in order to allow the separated particles to enter the dipleg. The form of the holes is not very critical. Circular, rectangular holes and slots are possible forms for the openings in the sieve.

The sieve is preferably positioned symmetrically around the axis just on top of the inlet opening of the dipleg. One embodiment of the invention is where the sieve is a tube placed on top of the dipleg which tube protrudes the circular housing from below. The tube has about the diameter of the dipleg and has an open lower end and a closed upper end. In the vertical walls of the tube holes are present.

The sieve is preferably sufficiently strong to avoid it being damaged by erosion due to the gas-solids moving in the circular housing. Protective linings can be applied to protect the upper part of the sieve. A more preferred method of protecting the sieve is by positioning a vortex stabiliser below the opening of the gas outlet tube and above the sieve. The vortex, present in use, will end at the top of the vortex stabiliser thereby reducing erosion of the sieve. The vortex stabiliser will additionally further reduce any swirl movement in the dipleg and thus increases the pressure difference per length of dipleg, which is advantageous for the reasons set out earlier.

The vortex stabiliser comprises suitably of a hat having a relatively large diameter and a vertically oriented vortex stabiliser rod placed on top of the hat having a considerably smaller dimension relative to the hat. The hat may be for example a circular plate or a cone. When a cone is used the top of the cone may function as a vortex stabiliser rod. Vortex stabilisers

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are also described in for example US-A-4692311,  
EP-A-360360 and EP-A-220768.

A preferred embodiment is where the vortex stabiliser  
is placed on top of the sieve.

5       The vortex stabiliser may have a hollow tube as  
vortex stabiliser rod, wherein a fluid connection is  
present via the hollow tube between the top of the vortex  
stabiliser and a position below the vortex stabiliser and  
above the inlet of the dipleg.

10       The inlet means for the gas-solids feed can be  
axially or tangentially arranged at the upper tubular  
part of the circular housing.

15       The apparatus is preferably used as the second  
separation step (also referred to as secondary cyclone)  
to separate catalyst particles from a gaseous reactor  
effluent of a fluid catalyst cracking process in which  
the separation is conducted in at least two sequential  
separation steps.

20       A fluid catalytic cracking process comprises a  
reactor in which catalyst particles and gaseous  
hydrocarbons are contacted. The reactor is generally a  
vertically positioned tubular reactor often referred to  
as the riser reactor through which catalyst and reactants  
co-currently flow in an upwards direction. At the end of  
25       the riser the catalysts are separated from the reactor  
effluent. This separation is usually effected by means of  
one or more cyclones. The thus separated catalysts are  
collected in a stripping vessel. In this vessel the  
catalysts are stripped with a water containing gas to  
30       separate any hydrocarbons from the catalyst. The stripped  
catalysts are subsequently send to a regenerator vessel  
in which any coke is removed from the catalyst by means  
of combustion. The stripped and regenerated catalyst is  
reused in the process.

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5 The separation of catalyst from the reactor effluent  
is suitably performed by means of a first separator which  
separates the bulk of the catalyst, followed by a  
secondary cyclone which separates most of the remaining  
catalyst particles. Depending on the specific layout more  
than one secondary cyclone may be present operating  
parallel and/or in series of each other. These separator  
means may be placed inside the stripping vessel or  
outside the stripping vessel. Combinations of the two are  
10 also possible, wherein the primary separation means is  
placed inside the stripping vessel and the secondary  
cyclone is placed outside the stripping vessel. The  
advantages of the invention are especially apparent when  
the secondary cyclone is placed inside the stripping  
15 vessel because these cyclones cannot be easily inspected  
when the FCC process is in operation. Examples of such  
FCC configurations are described in the earlier cited  
patent publications US-A-5055177, US-A-5391289, EP-A-  
309244 and EP-A-299650. If the secondary cyclone is  
20 placed inside the stripping vessel the gas-solids feed  
inlet is preferably tangentially arranged.

Preferably both the primary separation means,  
suitably a cyclone also referred to as the rough cut  
cyclone, and the secondary cyclone are placed inside the  
25 stripping vessel. More preferably the gas outlet of the  
rough cut cyclone is in fluid connection with the inlet  
of the secondary cyclone. This is advantageous because  
the residence time of the cracked hydrocarbons after they  
leave the reactor riser in the different separation means  
30 is hereby reduced so as to avoid non-controlled cracking  
also referred to as after cracking. In order to have an  
outlet means for the stripping gases in the stripping  
vessel an opening is present in the conduit between the  
rough cut cyclone and the secondary cyclone. Preferably  
35 this opening is effected by a slit.

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5 In Figure 1 a separator apparatus according the  
invention is shown having a hollow circular housing (1),  
symmetrical around an axis (Ax), fluidly connected to a  
dipleg (8) a gas outlet tube (4), inlet means (3) for the  
gas-solids feed, tangentially arranged to create, in use,  
a vortex flow in the circular housing (1). The inlet  
means (3) is fluidly connected to an inlet conduit (2).  
The circular housing (1) has upper tubular portion (5)  
with a diameter (D3), a frusto-conical envelope as a  
10 middle portion (6) of which smallest diameter (D2) is at  
the lower end and a lower part (7) having a diameter  
(D1). A tubular sieve (9) with circular openings (10)  
covers the inlet of the dipleg (8). Also shown is a  
vortex stabiliser (11) positioned on a hat (12).

15 In Figure 2 the numbers have the same meaning as in  
Figure 1. The embodiment disclosed in Figure 2 differs  
from the one disclosed in Figure 1 in that no widened  
lower part of the housing is present.

20 In Figure 3 a tubular sieve (9) is shown with  
rectangular openings (10) covering the inlet of the  
dipleg (8) placed in the lower part (7) of the housing.  
On top of the sieve a vortex stabiliser (11) is  
positioned. The hat (12) of the vortex stabiliser forms  
the top of the tubular sieve (9).

25 Figure 4 represents a preferred stripping vessel (16)  
of a FCC process having a secondary cyclone according the  
invention. The upper part of the stripping vessel is  
shown in which a reactor riser (17) is fluidly connected  
to a rough cut cyclone (18), which rough cut cyclone is  
30 fluidly connected with a gas outlet conduit (19). In the  
horizontal part of this conduit (19) a slit (21) is  
present. Conduit (23) is in fluid connection with the  
tangentially arranged inlet of the secondary cyclone  
(24). The secondary cyclone (24) has a coke catcher (25)  
35 covering the inlet of the dipleg (26). The gaseous

product poor in catalyst particles leave the secondary cyclone and the stripping vessel via conduit (27). The lower part of the stripping vessel comprises a fluid bed of catalyst particles (28) to which stripping gas is supplied to via inlet means (29). The dipleg (26) of the secondary cyclone ends about at the upper level of the fluidized bed (28) and the dipleg of the rough cut cyclone (30) ends within the fluidized bed (28). Through the slit (21) stripping gases can enter the inlet (21) of conduit (23) and leave via the secondary cyclone (24) the stripping vessel (16).

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C L A I M S

1. A separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the separator comprising:

5 an upright hollow circular housing fluidly connected to a dipleg for discharging solids positioned below the housing;

a gas outlet tube for discharging the gas-rich stream from the circular housing, which outlet tube protrudes substantially co-axial from the top of the housing;

10 inlet means for the gas-solids feed so arranged to create, in use, a vortex flow in the circular housing;

and a sieve positioned between the lower part of the circular housing and the upper part of the dipleg, which sieve has openings which do not allow particles having a diameter greater than 0.75 times the diameter of the dipleg to pass the sieve and enter the dipleg and wherein the total area of the openings in the sieve is greater than 2 times the cross sectional area of the dipleg.

2. Apparatus according to claim 1, wherein the openings of the sieve do not allow particles greater than 0.5 times the diameter of the dipleg to pass the sieve.

3. Apparatus according to any one of claims 1-2, wherein the total area of the openings of the sieve is greater than 5 times the cross sectional area of the dipleg.

25 4. Apparatus according to any one of claims 1-3, wherein a vortex stabiliser is positioned co-axial to the central axis below the opening of the gas outlet and above the sieve.

30 5. Apparatus according to claim 4, wherein the vortex stabiliser is placed on top of the sieve.

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6. Apparatus according to any one of claims 1-5, wherein the inlet means for the gas-solids feed are tangentially arranged at the upper part of the circular housing.

5 7. Fluid catalyst cracking process in which catalyst particles are separated from a gaseous reactor effluent in at least two sequential separation steps, wherein the apparatus according to any one of claims 1-6 is used in the second step.

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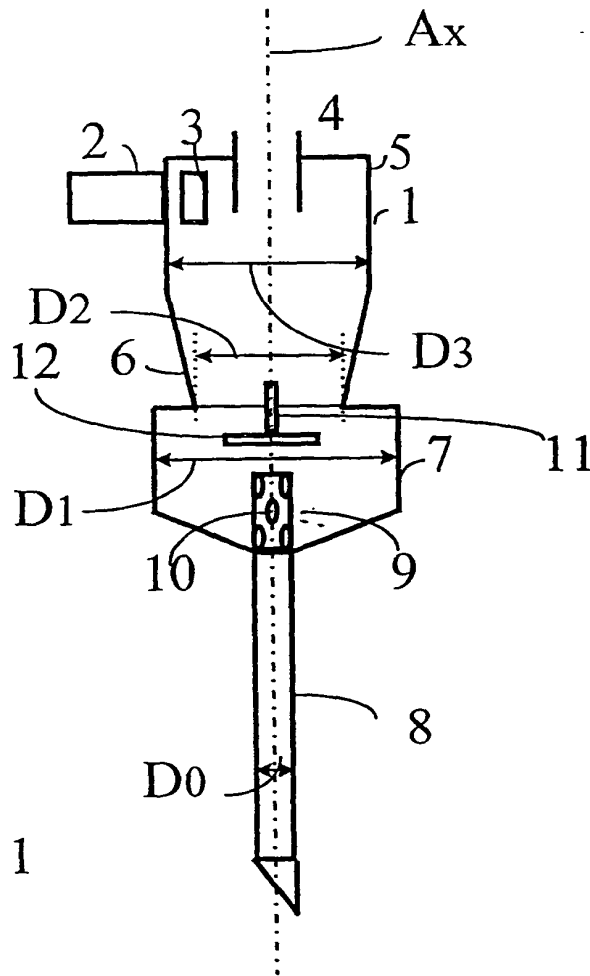


Fig. 1

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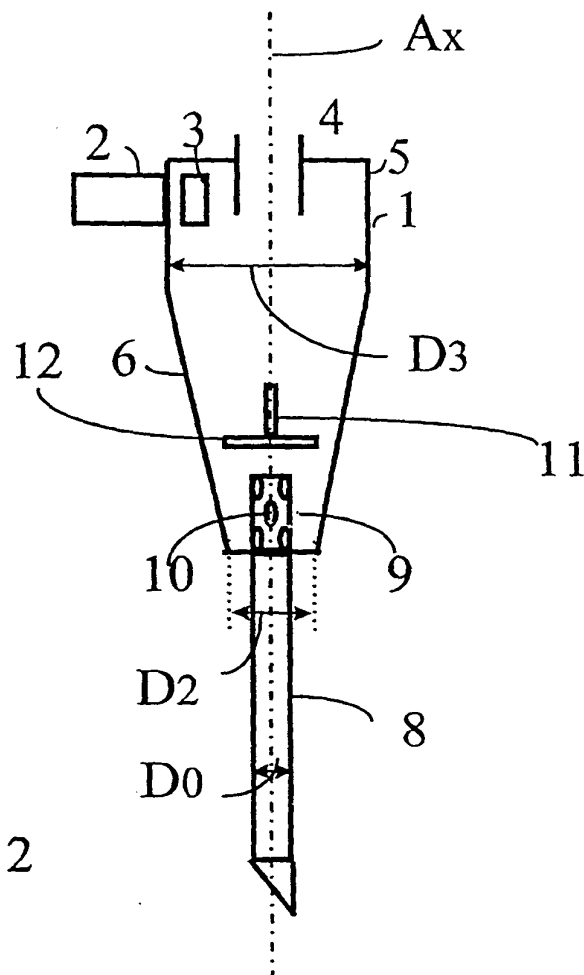


Fig. 2

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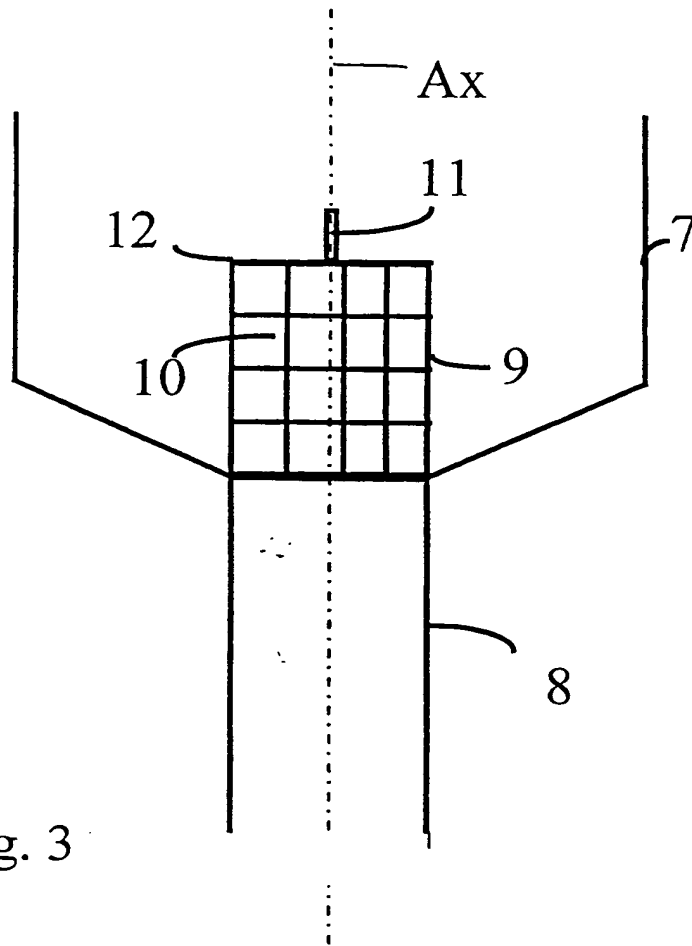


Fig. 3

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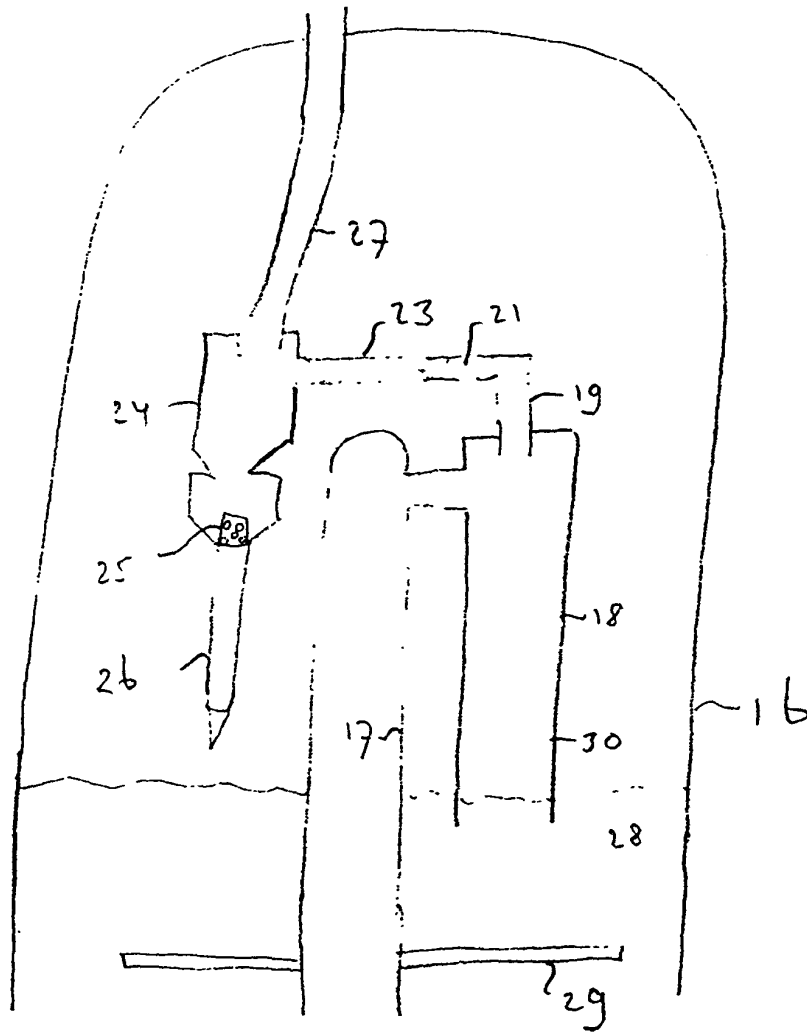


Fig. 4